NOAA FISHERIES

Climate Change & Ocean Productivity

Global climate change has the potential to dramatically alter marine ecosystems. The NWFSC is engaging research to understand and mitigate its likely effects:

- *Long-term studies of plankton and oceanographic conditions in the California Current.*
- *Developing models of ecosystem interactions, from phytoplankton to top predators.*
- *Indentifying factors that affect salmon productivity in the ocean.*

Climate variation is recognized as a primary driver of ocean ecosystems and their associated biological resources. This is seen clearly along the Pacific Northwest coast, where fluctuations in fishery stocks (including salmon, Dungeness crab, Pacific hake, sardines, anchovies) and other species such as krill and smelt have been explained by climate patterns. Northwest Fisheries Science Center staff focus on understanding climate-production relationships along the Oregon and Washington coasts, to predict the ocean's productivity, such as salmon run sizes. We do this through a combination of fundamental research, long-term monitoring, and data synthesis. Through these studies, we expect to gain better understanding of the control of coastal resource production, make better predictions of resource status, and better assess the effects of human management on these systems. We currently have three main areas of research:

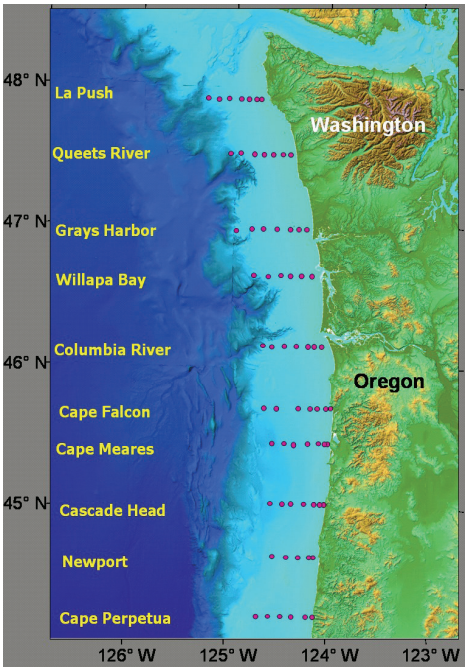
Zooplankton ecology and monitoring

NWFSC scientists conduct biweekly hydrography and plankton cruises off the coast of Newport, Oregon. These cruises were initiated in May 1996 and continue to present. On each cruise, we measure hydrographic conditions and sample zooplankton at stations ranging from 1 to 25 miles from shore. We set up incubations of living plankton for euphausiid (krill) molting rates, adult female euphausiid brood sizes, and copepod egg production (*Calanus marshallae, C. pacificus* and others).

Surveys of the hydrography and zooplankton are also conducted along the Washington and Oregon coasts in May, June, and September as part of a study of habitat requirements of juvenile salmon funded by the Bonneville Power Administration. Larger scale surveys from northern California to the northern tip of Washington coast are conducted as part of the PaCOOS (http://www.pacoos. org) program when we have access to larger oceanographic research vessels.

Ecosystem modeling and analysis

Our ability to predict biological changes resulting from climate change depends on understanding processes sufficiently to quantify relationships among the various parts of the ecosystem. We use two types of models to accomplish this. Statistical forecast models are used to estimate future conditions from past conditions, such as predicting salmon adult run sizes from spawner abundance and recent environmental conditions. Process models are used to test our understanding of ecosystem responses against real world data. We use biophysical models to relate plankton production to physical ocean circulations along the Oregon and Washington coasts. We also use full ecosystem models to track the ecological interactions from phytoplankton up to top predators (such as sharks, sea birds, and marine mammals).



Ocean indicators of salmon production

We use three sets of ecosystem indicators to aid in understanding the ecological interactions among juvenile salmon and their environment. The first set is based on large-scale oceanic and atmospheric conditions in the North Pacific Ocean, and consists of the Pacific Decadal Oscillation (referred to as PDO) and the Multivariate El Niño Southern Oscillation Index (ENSO). The second set of indicators is based on local observations of physical and biological ocean conditions off Newport, Oregon. The third set is based on biological sampling of plankton, juvenile salmonids, forage fish, and Pacific hake off Washington and Oregon as part of a research program funded by the Bonneville Power Administration. From this combination of physical and biological indicators, we produce forecasts of adult salmon returns.

Learn more about how ocean indicators are used to predict annual returns of adult Chinook and coho salmon at http://www.nwfsc.noaa.gov/research/hottopics/salmon_forecasts.cfm.

Wind patterns, ocean currents, and upwelling all affect marine organisms. All of these can be altered by climate change.

Euphausiid (krill)

Copepod (*Calanus marshallae*)

Learn more:

Sharing our work with other scientists, with policymakers, and with the public is important to us. To learn more about what we do, please visit our:

Website: www.nwfsc.noaa.gov
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